Accessible Online Courses

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1 What all can/shall be accessible in academic settings

When ensuring accessibility of higher education for students with disabilities, several aspects need to be taken into account:

- physical environment > university premises (buildings), equipment within the premises
- **virtual environment** > information systems and e-learning environment, administrative procedures, content of teaching and learning materials
- work and study technologies (e.g. laboratory apparatus, software…)
- communication and teaching methods

In the text below, we will pay attention to the accessibility of virtual environment only.

2 Accessible Information and Communication Systems (virtual environment)

In order to organize studies, related administration and general operation, universities commonly use web interfaces, internal and external applications and systems which are hoped to be used by students and other academics effectively based on their needs. Therefore, it is vital that not only the content offered through these platforms but also the interface itself should be designed in such a way so it would not create unwanted barriers which exclude some users and prevent them from using these platforms.

With regard to objective limitations of individual categories of users, one can claim that the ability to effectively work with these tools is dependent on technical design of the virtual interface (on the coding level) and on the overall graphical and language user interface of the systems. Generally it may be said that principles which ensure the highest possible accessibility for persons with disabilities to any digital learning material as soon as it is created are, to a large degree, identical with requirements in general:

- an exact and clear course structure corresponding to a clearly expressed educational aim,
- clear and correct standard language, which is complicated in correspondence with the educational aim (thus not more complicated than it is necessary for the given aim),
- a proper technical solution, i.e. one in correspondence with valid norms for the source code.

Moreover, it has to be remarked that two significant changes are taking place in academic settings:

1. increasing tendency to transfer academic tuition to a digital platform (distant online learning, blended learning, etc.), and
2. extensive possibilities available to the general public that enable creating and publishing digital educational content easily.

Those trends imply higher necessity to pay attention to both technical and sensorial accessibility of the digital content. While accessibility of digital platforms themselves (mainly web interface of the systems) can be achieved by conforming them to the existing guidelines on web accessibility (i.e. WCAG, ARIA, ATAG), achieving accessibility of the content (text, tabular data, graphics, multimedia…) means continuous consideration of (at least) elementary principles of accessibility which are derived from sensorial, physical and cognitive conditions (limitations) of each user group with disabilities.

3 User Groups with Disabilities

Typology[1]

A. Users with visual impairment

A1. Partially sighted person / screen user: A person whose visual impairment enables the use of sight (and also text), with common document formats, including the visual ones. The modification is based on zooming and other changes of optical character, it is not necessary to use a screen reader.

A2. Legally blind person / Braille or speech output user: A person who works either with tactile print documents or screen readers (in combination with tactile display and speech output), which requires an editable text document format or a document adapted in content and form. This category includes also persons who are commonly described as severely visually impaired, blind, or practically blind.

B. Users with hearing loss

B1. Hard-of-hearing person / spoken language user: A person who spontaneously receives and produces spoken language (in speech and writing). This category includes also persons who are from the medical point of view described as deaf (or deafened), but who are primarily users of spoken language, not sign language.

B2. Deaf / sign language user: A person who spontaneously receives and produces sign language, or another form of nonverbal communication.

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[1] The classification of disabilities is based on aspects relevant to studying at an institution of higher education and takes into account their financial impact. Medical point of view is used as input information to support the basic objectivity of the claims but not as a decisive aspect for classification into individual subcategories. The subcategories are based consistently on the functional principle of the classification, even if their names can imply medical diagnosis.
As a resource for the the typology built on the functional principle served a methodical document of the Czech Ministry of Education, Youth and Sports: "*Rules for providing support to public universities*" (Rules, 2018).

C. Users with mobility impairment and hidden disabilities

C1. Person with impairment of lower limbs (paraplegia): A person who — with regard to his/her mobility impairment — requires and uses various personal equipment for independent movement, such as walking sticks, or mechanical or electric wheelchairs. This category includes also persons whose medical diagnoses states only the cause (e.g. cerebral pulsy) and not the effects on the function of the locomotor system.

C2. Person with impairment of upper limbs (fine motor skills): Fine motor skills are disturbed to such extent that a person is not able to operatively and effectively carry out activities, which are common during study — taking notes in hand or on keyboard, manipulation with objects and equipment which are indispensable for the fulfilment of study obligations (physical books, stationery, instruments etc.), or manipulation with objects of daily use.

C3. Person with hidden disabilities: A person who objectively can not fulfil study obligations in the standard manner due to another mental disorder or disease including neurodevelopmental disorders, i.e. disturbed language, speech and other communication skills, or chronic disease, and requires organizational measures from the side of the educational institution.

D. Users with specific learning disorders

A person who objectively can not fulfil study obligations in the standard manner due to dyslexia, dysorthography, dyscalculia, dyspraxia, often parallel with ADHD (hyperactivity with attention disorder). The disability can appear in inadequate development of specific academic, language, and speech skills (reading, writing, mathematics).

Impact on work

A. Users with visual impairment

Screen users: visual impairment still allows them to work with normal document formats using sight, image modification is limited to enlargement or other optical changes.
Braille or speech output users: works either with printed Braille documents or with a screen reader (in combination with a Braille display or speech synthesis) requiring an editable text format. Visually impaired persons rely on an assistance of a supportive software: screen reader or software for enlarging text.

1. Voice and tactile outputs are both linear and textual; it is never possible to follow more pieces of information at the same time, only sequentially so, one sign after another. This way of perceiving may be in conflict with:

   a. cases, where it is necessary to simultaneously follow two parts of a text when working with a material (for example, in linguistic exercises aimed at filling gaps with listed answers or, in mathematics when comparing an expression before and after modification), see fig. 1;
   b. an extensive, non-symmetrical table (i.e. such that is not defined by a simple distribution of columns and rows), pictures, see fig. 2a, 2b;
   c. information arising only from layout and formatting are not accessible and of any

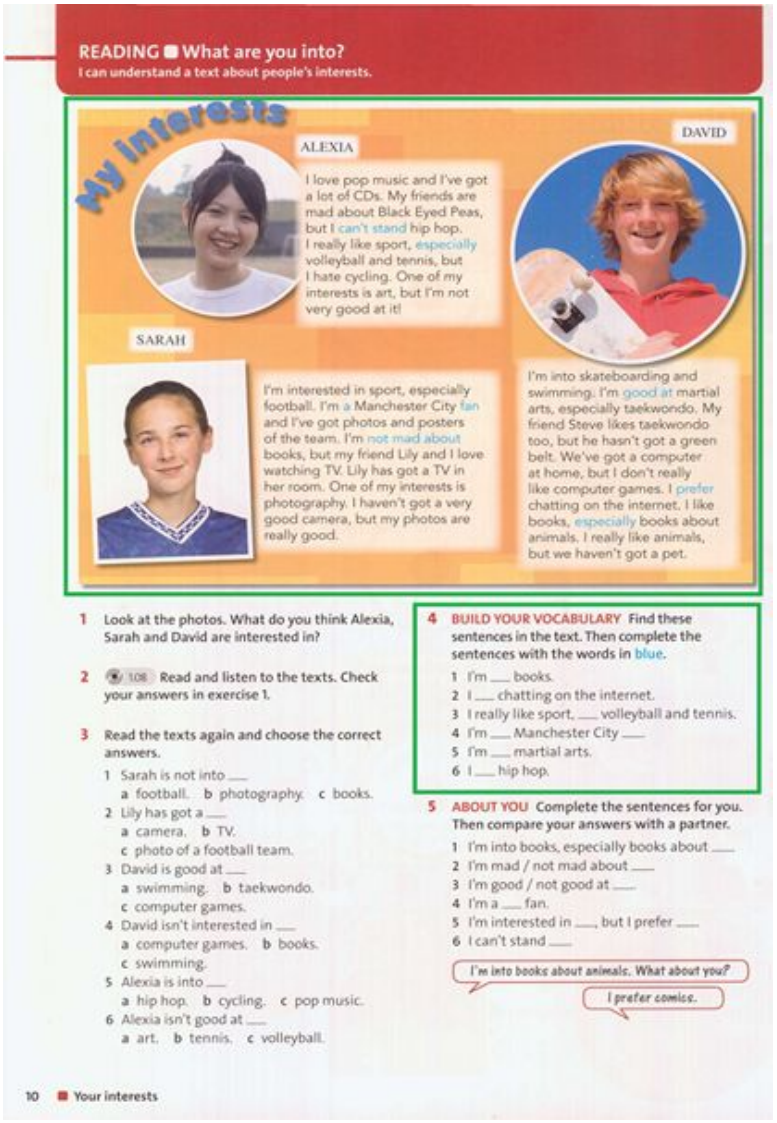
use (see fig. 3), e. g. information following from the colour or a mere closeness of words or objects on a screen (a seeing person automatically interprets objects which are displayed closely together or on the same level as related, parallel, equivalent, and so on, without any verbal commentary).

The accessibility of **a)** can be solved by an appropriate labelling of structures (a beginning of a list of entries and a beginning of a text) by keywords or headings, which a user can use for quick navigation; it is possible to solve the case of **b)** by an adaptation of a table into a symmetrical form (the same number of columns and rows at all times) with a newly formulated cells in the head; and **c)** may be solved when words or objects with a corresponding content are not visually connected with technical means that in fact separate them (frames, columns, and others).

2. Neither voice nor tactile output can be used to grant access to graphical objects (including specialized symbols, see fig. 4b, 4c) or, by no means, to objects whose understanding is based on spatial imagination (see fig. 4a). A description or verbal commentary of such objects can partially substitute for them on an informative level. But if the aim of work with such material is to give a person with a visual impairment a similar effect as to others, it is inevitable to make a two-dimensional model (a sheet with tactile graphics) in the case of two-dimensional graphics and a three-dimensional model of an object in case of graphics visualizing spatial objects.

Leaving aside the unrealistic nature of a large number production of such copies, working with them rarely creates an identical psychological impact (a perception of such objects is more complex than the perception of words).

Figure 1: The green rectangles mark the parts of page which student needs to combine when fulfilling the task. Students can perceive only a part of the page (that is only a line) when using a screen reader (whether in combination with a Braille display or speech synthesis). Therefore, student who uses only the screen reader when doing the task needs a far more time to fulfil it, or he or she needs additional instructions in the source document.



READING ■ What are you into?

I can understand a text about people's interests.

My interests

ALEXIA

I love pop music and I've got a lot of CDs. My friends are mad about Black Eyed Peas, but I can't stand hip hop. I really like sport, especially volleyball and tennis, but I hate cycling. One of my interests is art, but I'm not very good at it!

DAVID

I'm into skateboarding and swimming. I'm good at martial arts, especially taekwondo. My friend Steve likes taekwondo too, but he hasn't got a green belt. We've got a computer at home, but I don't really like computer games. I prefer chatting on the internet. I like books, especially books about animals. I really like animals, but we haven't got a pet.

SARAH

I'm interested in sport, especially football. I'm a Manchester City fan and I've got photos and posters of the team. I'm not mad about books, but my friend Lily and I love watching TV. Lily has got a TV in her room. One of my interests is photography. I haven't got a very good camera, but my photos are really good.

1 Look at the photos. What do you think Alexia, Sarah and David are interested in?

2 1.08 Read and listen to the texts. Check your answers in exercise 1.

3 Read the texts again and choose the correct answers.

1 Sarah is not into ___
a football. b photography. c books.
2 Lily has got a ___
a camera. b TV.
c photo of a football team.
3 David is good at ___
a swimming. b taekwondo.
c computer games.
4 David isn't interested in ___
a computer games. b books.
c swimming.
5 Alexia is into ___
a hip hop. b cycling. c pop music.
6 Alexia isn't good at ___
a art. b tennis. c volleyball.

4 BUILD YOUR VOCABULARY Find these sentences in the text. Then complete the sentences with the words in blue.

1 I'm ___ books.
2 I ___ chatting on the internet.
3 I really like sport, ___ volleyball and tennis.
4 I'm ___ Manchester City ___
5 I'm ___ martial arts.
6 I ___ hip hop.

5 ABOUT YOU Complete the sentences for you. Then compare your answers with a partner.

1 I'm into books, especially books about ___
2 I'm mad / not mad about ___
3 I'm good / not good at ___
4 I'm a ___ fan.
5 I'm interested in ___, but I prefer ___
6 I can't stand ___

I'm into books about animals. What about you?

I prefer comics.

10 ■ Your interests

Figure 2a: A sample of a non-symmetric table. In the columns, there is a different number of rows — that causes technical and perception difficulty especially when using screen readers.

Interval of coefficient of correlation	Character closeness of the connection between the factors			
	existing classification	scale for technical measurements	scale for precision measurements	scale for genetic engineering and ranks of the whole simple numbers
1	strong connection	unambiguous	unambiguous	unambiguous
0.999...1.0000		the strongest	almost unique	almost unique
0,99...1,000				extremely strong
0,95...0,99			super strong	super strong
0,90...0,95			the strongest	the strongest
0,7...0,9		strong	strong	strong
0,5...0,7	weak connection	average	average	average
0,3...0,5		rather weak	rather weak	rather weak
0,1...0,3	no connection	weak	weak	weak
0,0...0,1		weakest	weakest	weakest
0		no connection	no connection	no connection

Figure 2b: An intensive map for presenting election results.

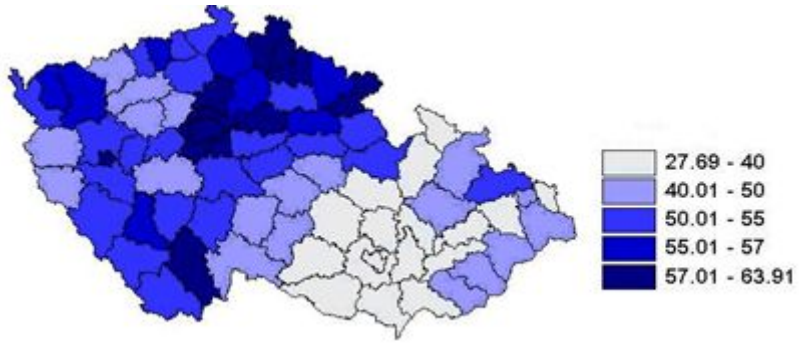
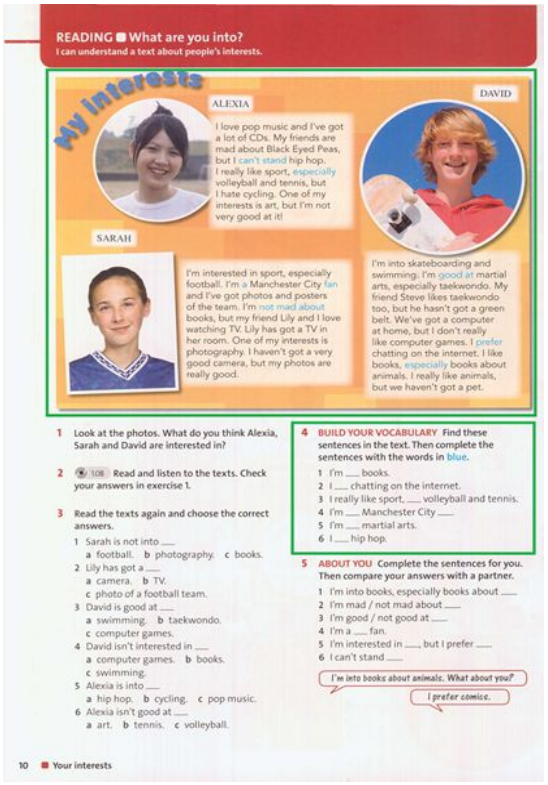


Figure 3: Student has to work with words highlighted in blue, which makes the task virtually impossible to solve to those whose technology is not capable (or with great difficulties) of acquiring the font colour.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4 I'm a .... fan.
5 I'm interested in ...., but I prefer ....
6 I can't stand ....

I'm into books about animals. What about you?
I prefer comics.

10 ■ Your interests

Figure 4a: Mathematical formula, which cannot be read with the screen reader and needs to be modified into another form (for details see e.g. Teiresias, 2014).

$$\sqrt{\frac{(x+1)^2}{(x+1)(x-1)} + \frac{x^2}{x-1}}$$

Figure 4b: An example of a chemical equation – for the legally blind students the text should be transformed into another form. The most appropriate one can be physical document embossed in braille.

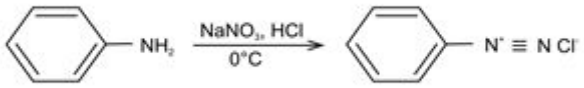
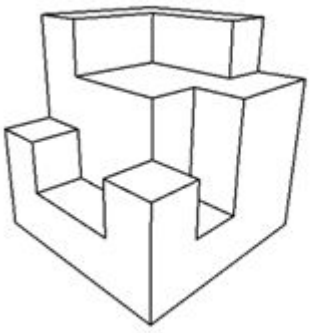


Figure 4c: A part of spatial imagination test.



The figure is fragment of a cube originally consisted of 64 small blocks. How many of the blocks are needed to get the complete cube.

(A) 22
(B) 18
(C) 19
(D) 20
(E) 21

B. Users with hearing loss

Limitations on the psychological and perceptual level in case of sign language users can affect the ability to learn spoken language or to use it effectively. As a consequence, the language deficiency can reduce ability to get oriented in extensive texts. As a compensation there are some adjustments recommended to be taken:

- Textual parts must have a rigid structure (e.g., use lists and similar textual organizing elements) and its crucial parts must be highlighted relatively to others.
- In case a text includes marginal vocabulary expressions (historicisms, poeticisms, colloquialisms) or low frequency scientific terms which are not explained as part of the course, it is suitable to include some form of dictionary into the course. Linguistic elements mainly used in spoken communication (social conversation, telephone calls), high frequency of adjectives and others create a serious barrier.
- It is recommended to provide a learning material with visual and interactive elements. Graphs, animation, pictures, and interactive presentations supplement the main part of the material and they have an irreplaceable role in the didactics and teaching methods of the hearing impaired, they illustrate meaning of words and make a conveyed information more interesting and, first of all, easier to understand and accept; this actually holds for the hearing, too. On the other hand, this usually presents an insuperable obstacle for the visually impaired, so there is no format suitable for both types of impairment.
- Inductive method of instruction should take priority over deductive methods where this is possible according to a topic and nature of a subject matter; also, it is necessary to build definitions of abstract terms on concrete ones. It is also a good idea to double check the orientation in vertical structure of terms in use (hyponyms and hypernyms) as the hierarchy of terms need not be a priori clear to a sign language speaker.

- A course should include more parts devoted to practising acquired knowledge, its following testing and regular repetition. Given the effort a deaf person must make to understand a text and the structural difference of the code spontaneously worked with, the pedagogical impact of information in spoken language is never as permanent as in the case of hearing students.
- Key passages in a text (for example definitions and propositions in mathematics) and extended text passages should be accompanied with a translation to a sign language (i.e. with a video recording of an interpretation of a given text into sign language by an interpreter). This is similar to the situation when audio files are included.

C. Users with mobility impairment and hidden disabilities

In case of users with mobility impairment (especially impairment of lower limbs), the capability to perceive texts in commonly used formats is usually not influenced. However, limitations in the use of hands (impairment of upper limbs — shaking and damage of finger motor capacities cause that manual control can be reduced) or their complete exclusion may radically modify their possibilities to use computers. Such cases mostly need to be taken care of by individual supportive hardware devices (adapted mouse, keyboard, eye-typing, etc.). But, as far as the accessible form of digital documents is concerned, we can claim that there is no special need which goes beyond the general principles mentioned above and these users can also benefit from the documents prepared for another target group.

D. Users with specific learning disorders

When compared to mainstream population, persons with dyslexia have significantly lower reading skills and further specific disadvantages in their profile related to a number of cognitive functions can be found among them as well. In consequence, impact of these disorders and difficulties can be compared, in some cases, to impact of hearing impairment, especially when it comes to psychological and perceptual issues, especially:

- difficult orientation in text
- reduced capability to perceive complex expressions or compound words
- slow reading speed, foreign language deficiency

As a compensation of those issues, there are some adjustments of documents and courses recommended to be taken:

- keeping consistent and precise structure of a document or course (headings, lists);
- highlighting crucial parts of text;
- supplementing more complex textual information with interactive or graphical elements;
- including some form of dictionary or glossary to a document or course, especially of important terms from marginal vocabulary;
- supplementing a course with tools that support users to keep overview of passed and pending tasks, activities, progress and to manage user’s time to accomplish tasks (e.g., time-line, completion tracking, task lists, etc.);
- individual use of spelling and grammar checking tools, synonym dictionary to support user’s reading and writing

In case of severe dyslexia and dysorthography, some technical solutions that compensate the difficulties are comparable to techniques for users with visual impairment, especially accessing text information using reading aloud (screen reading) technologies. That is why requirements of these users on accessibility of documents are, to a certain extent, in common with requirements of blind users (Braille or speech output users).

Key Principles of Accessibility

1. Keyboard operation

The ability to operate applications fully via the keyboard.
This means supporting the standard keyboard shortcuts available for the operating system, such as Alt+F4 to close a window of a Windows application, and F1 to open the Help file. It may also be useful to provide special shortcuts for the application, such as the spacebar to toggle the 'play' and 'pause' buttons of a media player.

2. Compatibility with assistive technology

Compatibility with screen readers and text readers, screen magnifiers, voice input, switch input. This may mean implementing the application for a widely used environment, such as Windows, Mac or UNIX, and adopting the accessibility standards of that Operating System (OS).

For screen magnifiers, this means providing text as pure text, rather than as images, so that the text is not distorted when it is magnified. It also means controlling the quality of pictures so that they do not distort when magnified.

3. Screen reader access

Allowing interface objects and other content to be read by a screen reader, and to be read in a meaningful way. This means providing appropriate text labels on all buttons, menus and menu items, icons, sliders, and all other interface objects. In order for these objects to be read in a meaningful way they need to be placed in a logical order, and the order needs to be consistent across different screens.

4. Descriptions of visual content

Description of visual material may be required, depending on the application or the purpose of the content. In an educational context a multimedia package should provide text descriptions of important visual information. For example, data shown in a graph or a photograph of a sculpture may need to be described. The need for a description depends very much on the purpose of the visual information, i.e. pictures used for decoration may not need to be described, but pictures that convey meaning may need to be described.

5. Customisation

The ability to inherit operating system settings for colours/fonts, or the ability to customise display.
Inheritance of users' settings: the ability of software to inherit operating system settings. Dyslexic and partially sighted people may make changes to the operating system display settings; e.g. making all text one colour and all backgrounds another colour. In practice, this means designers and developers should not override operating system settings with software settings. An alternative approach can be to provide users with a choice of fonts

and colours to be used as the default settings. However, a drawback of the latter approach is that it is difficult to provide a range that accommodates the needs of all partially sighted or dyslexic users. It is, therefore, preferable to inherit the user's existing settings.

6. Control over audio output

The ability to adjust volume and tone and to link hearing aids to amplifiers, speakers or induction loop systems.
In practice this applies more to interactive devices located in public areas, such as libraries or shopping centres, where the relevant controls and connections need to be provided. For PC-based software this requirement will be met by the operating system and the user's own equipment.

7. Alternative to speech input

People who cannot speak may require an alternative to speech input facilities such as audio conferencing. In practice this would probably mean the provision of text-based facilities in addition to the speech input.

8. Alternative to text output

Deaf people who cannot read or write text because sign language is their primary language may require an alternative to text output or text entry. In practice this might mean the provision of pictorial information as output or in a menu, or even the provision of a signing avatar (software that creates an animated sign language interpreter).

9. Alternative to colour

Colour-blind people may require information that is conveyed through colour to be conveyed in another way. In practice this may mean giving coloured objects text labels or differentiating their appearance in other ways. For example, if important information is presented in red, it could also be labelled as ‘important’ or highlighted in another way.

10. Clear, consistent design

This means using common navigation tools, such as menus, meaningful icons and so on, and applying them consistently throughout the site. This helps those using assistive technology and students with dyslexia.

Those and more principles are included in primary web accessibility guidelines that are regarded as international standard — Guidelines of W3C (World Wide Web Consortium):

- Web Content Accessibility Guidelines (WCAG, 2017)
- WAI — Accessible Rich Internet Applications (ARIA, 2014)
- Authoring Tool Accessibility Guidelines (ATAG, 2013)

Accessible Documents of Specific Formats

Commonly used formats of learning materials:

- hard (printed) copies (textual and graphical);
- electronic text materials with editable text layer, with non-editable text layer, with two-layers (e.g. PDF), without text layer (e.g. PDF with only graphical layer etc.);

- electronic spreadsheets
- static electronic images
- video documents
- audio documents

The following list of formats and files most frequently used for a presentation of learning materials is accompanied with brief commentaries about their accessibility. Accessibility of various formats is considered primarily from a technical perspective, i.e. such techniques of use of a given format are mentioned which eliminate basic barriers for working with them disregarding psychological and perceptual limitations of a disability. This list of formats is by no means complete; it is necessary to consider possibilities and limits of accessibility of the less frequent ones individually.

Plain Text Files

It is often used for publishing technical data where further formatting does not make sense, for example program source codes. In case of texts of other characteristics, these do not create a fundamental barrier for a users when the content structure is simple and there is only insignificant semantic information about the text, which this format cannot keep with the text.

Documents of Word Processors (e.g. DOCX, ODT, .PAGES)

From the perspective of technical accessibility, no fundamental barriers appear for a vast majority of files in these formats if a document is correctly structured (for example, styles with an appropriate level are used for structure labelling, bullet and number lists and footnote functions are used to label objects of the given type, and so on) and graphical objects are equipped with a textual label (alternate text). A further limitation of accessibility may result from a psychological and perceptual limitation of a visually impaired person; a visually impaired person's knowledge of and experience with possibilities of supportive technologies in accessibility of the word processing application is a factor which is no less important because it influences the accessibility of documents individually.

Spreadsheet Documents (e.g. XLSX, ODS, .NUMBERS)

From the point of view of accessibility, it is always more appropriate to present data with table structure in the table format rather than attempt to interpret them in another way, such as a purely textual one where, for example, there is no unambiguous information about the current cursor position, the cursor navigation does not respect cell areas, and data can only be followed by rows. It naturally holds that a document cannot express information in a graphical form, such as through various colours in the cell background. The accessibility condition for spreadsheet documents is the same as in the case of the preceding one — personal experience with possibilities of supportive technologies for work with the spreadsheet application.

Adobe PDF Document

This format of textual documents is one of the mostly used for a presentation of learning materials. Although it is often considered as hardly accessible for users with visual impairment, it is possible to eliminate its basic technical barriers if a document is

correctly encoded and features of the format enhancing accessibility are properly applied. Because PDF documents are mostly produced by exporting documents from other word processing and authoring tools, correctness of a resulting PDF document (structure labelling, correct text order, alternate texts of images, etc.) is conditioned by quality of the source document and capabilities of the tool converting source document to PDF. Generally speaking, technically accessible PDF documents have to contain text layer with correct semantic information (so called tags — tagged PDF) and as such, they are accessible for users with visual impairment and provide better user experience for other target groups as well as mainstream users.

On the other hand, in many cases PDF documents used as learning materials, are not of the correct manner. Typical issues that disrupt or violate accessibility are as follows:

- **security protection** against copying content or, moreover, protection that disables assistive technology to access the content — there is no way a user dependent on assistive technology could overcome this issue, that is why such security settings should not be applied;
- a PDF document contains **no text layer**, i.e. it conveys only graphical (scanned) copies of an original printed document — as such, no textual nor structural information can be provided to screen reader users, so they are excluded from using the document. Moreover, these sort of PDF documents has a negative impact on usability for other target groups, as well as mainstream users, because it disallows, for instance, text reflow, searching, fine magnification or color adjustment. If there is an objective purpose to convey original printed document in its graphical (scanned) form in the PDF, it should always be complemented with textual content of the original document in the second layer of the PDF file (two-layer PDFs), so the textual content is made accessible to screen reader users;
- a PDF document conveys textual content with **non-standard encoding of characters** and symbols — it prevents screen reader users from accessing the textual content in the same extent as preceding issues and for users who prefer another format than PDF the issue makes potential conversions difficult or impossible;
- a PDF document conveys textual content but **semantic and structural information is missing** or incorrect (see above).

Audio documents

All audio formats present no fundamental barrier for the users with visual impairment if they meet the requirement that an accessible application for opening a given audio format is available. However, it presents a fundamental barrier for the hearing impaired. In order to make the audio information accessible for this target group, only transformation to format based on text, graphics or symbols, possibly with translation to sign language (at least significant parts) can be applied.

Video documents

Users with visual impairment can only follow an audio component of a video document. A visual component needs to be substituted with a sound track describing it or at least a textual summary of the whole video file.

Vice versa it is applied for users with hearing impairment — they can only follow motion picture component of a video document. An audio track needs to be substituted with captioning (subtitling), ideally as visible on-demand (closed captioning). Most of video players (both online and offline applications) enable users to configure visibility of the captions, on condition that the captioning content is provided as a separate textual resource, not attached ("burned") onto video image.

Short summary

Taking into account the above stated information, the following could be considered as accessible formats (that is, in addition to commonly provided formats of learning materials):

For students with visual impairment:

- electronic text/spreadsheet documents, whether editable or not,
- tactile documents (textual and graphical),
- audio-documents (standalone or complementary audio track to a video recording)
- hybrid documents (hybrid books[2], DAISY books[3]);

For students with hearing impairment:

- textual documents with clear structure,
- video documents in sign language, video documents with subtitles (possible technologies: YouTube "Transcribe and Auto-Sync", Amara.org, Subtitle Edit[4])
- hybrid documents[5]

For students with upper-body disability:

- electronic textual, or graphical documents

For students with learning disabilities:

- editable electronic document

Taking the above listed overview into account, it is apparent that university has the obligation to create and offer such documents which are accessible on their own or the university has to ensure the creation of alternative accessible forms, which could be distributed in parallel.

An accessible document/a course — A summary

[2] Hybrid Book is a multimedia application which enables the user to follow its content simultaneously in the form of text, audio recording and image. It is designed primarily for users with severe visual or hearing impairment. The content of the publication can be viewed either as a text, an audio recording of this text or a video recording of the text translated into sign language. (Teiresias, 2018)

[3] Digital Accessible Information SYstem. DAISY digital book format is designed to be a complete audio substitute for print material and is specifically designed for use by people with print disabilities, including blindness, impaired vision, and dyslexia. Based on the MP3 and XML formats, the DAISY format has advanced navigation features in addition to those of a traditional audio book. (DAISY, 2018)

[4] http://www.nikse.dk/subtitleedit/

[5] see Teiresias, 2018.

Main target group	General principles	Extended accessibility
[A] students with visual impairment	**1. A proper technical solution**, in correspondence with valid norms for the source code, or using standard tools of a text editor. **2. Clear and correct standard language.** **3. An exact and clear structure of the material.**	- comprehensive adaptations for users of screen-readers - textual or audio description of the visual parts - tactile materials if needed
[B] students with hearing loss		- captioning for users with hearing impairment - SL interpretation (at least significant parts) - glossary feature - graphic and interactive items
[C2] students with impairment of upper limbs		-
[D] students with spec. learning disorder		- graphic and interactive items - reading support tools - spelling and grammar checking tools - synonym dictionary

References

Amara (2018): *Amara. Subtitling Platform* [online]. Participatory Culture Foundation. [cit. 2018-04-08]. Available at URL: <https://amara.org>.

ARIA (2014): World Wide Web Consortium, Web Accessibility Iniciative. Accessible Rich Internet Applications (ARIA) [online]. Copyright © 1994—2014 W3C [cit. 2018-04-02]. Available at URL: <https://www.w3.org/WAI/intro/aria>.

ATAG (2013): World Wide Web Consortium, Web Accessibility Iniciative. Authoring Tool Accessibility Guidelines (ATAG) [online]. © 1994—2013 W3C [cit. 2018-04-02]. Available at URL: <https://www.w3.org/WAI/intro/atag>.

DAISY (2018): DAISY Consortium. Creating the best way to read and publish [online]. © 2018 DAISY Consortium. [cit. 2018-04-08]. Available at URL: <www.daisy.org>

Nikse (2018): Nikolaj Lynge Olsson. *Nikse.dk — Subtitle Edit* [online]. [cit. 2018-04-08]. Available at URL: <http://www.nikse.dk/SubtitleEdit>.

Rules (2018): *Rules for providing support to public universities by the Ministry of Education, Youth and Sports, Appendix No. 3 Financing increased costs connected with the education of students with special needs* [online in Czech]. Last update February 2018. Ministry of Education, Youth and Sports. [cit. 2018-04-02]. Available at URL: <http://www.msmt.cz/file/45851/>

Teiresias (2014): Teiresias Centre. *Přístupnost e-learningu pro studenty se specifickými nároky (E-learning Accessiblity for Students with Disabilities)* [online]. ver. II. Brno: Masaryk University, 2014 (English version 2007) [cit. 2018-04-02]. Available at URL: <https://www.teiresias.muni.cz/download/pristupnost_e-learningu2014.pdf>, resp. <https://www.teiresias.muni.cz/download/e-learning_accessibility.pdf>.

Teiresias (2018): Teiresias Centre. *Hybrid Book* [online]. © 2018 Hybridní kniha. Brno: Masaryk University [cit. 2018-04-08). Available at URL: <www.teiresias.muni.cz/hybridbook>.

WCAG (2017): World Wide Web Consortium, Web Accessibility Iniciative. *Web Content Accessibility Guidelines (WCAG)* [online]. © 2017 W3C [cit. 2018-04-02]. Available at URL: <https://www.w3.org/WAI/intro/wcag>.